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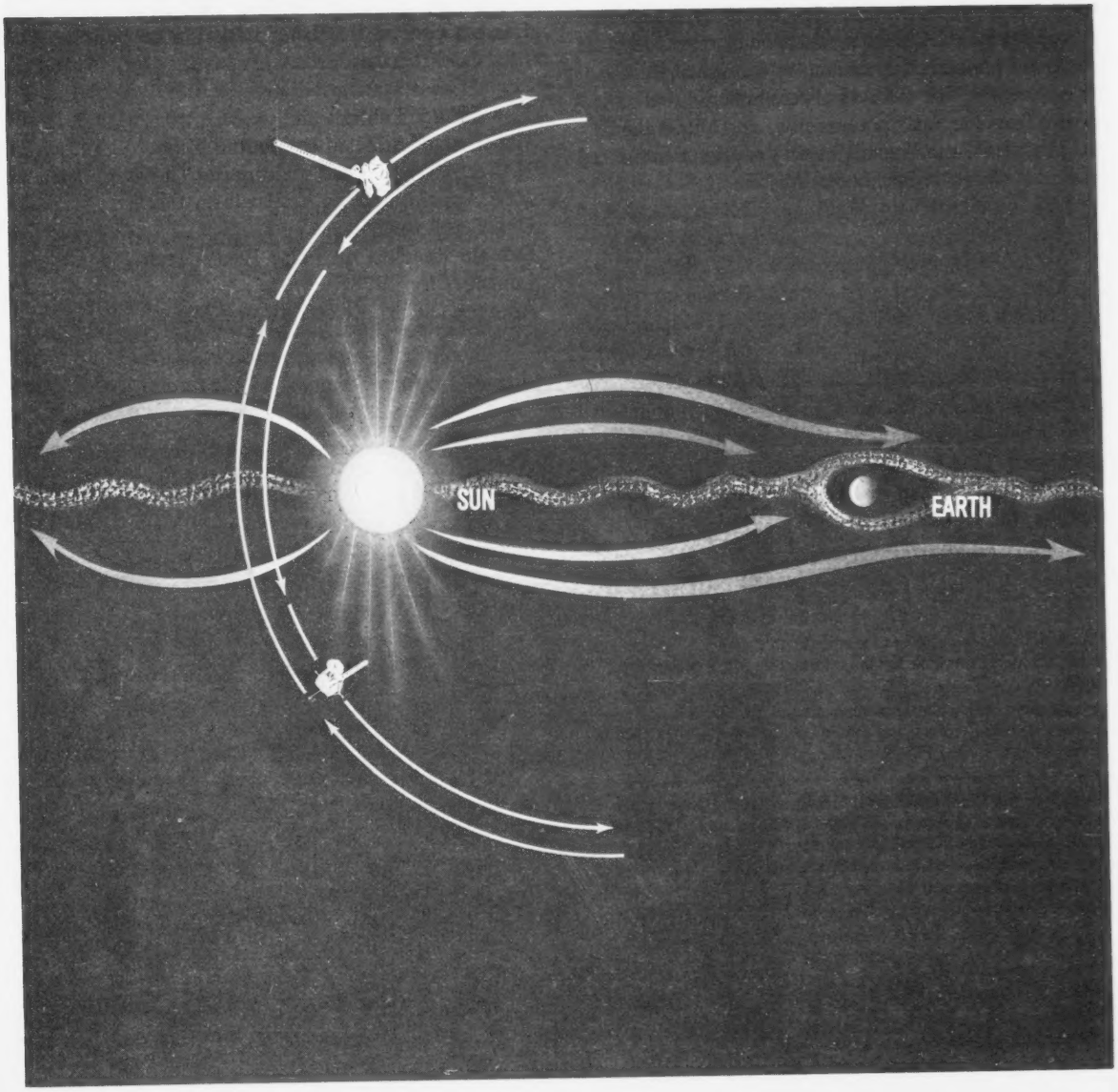

Cover

Solar Polar Mission—How an artist sees the proposed Solar Polar Mission, a venture designed to explore the three-dimensional space around the Sun by flying two spacecraft out of the ecliptic plane, the solar equatorial plane in which the planets lie, and over the poles of the Sun itself. (See double arc at left with two spacecraft that will criss-cross each other's path.) The unmanned mission is expected to contribute important new data on many of the solar phenomena —the solar wind flow and cosmic rays, for example— that shape and control the space environment of our own Earth. (The solar wind is indicated by the snakelike feature in middle of picture.) NASA and the European Space Agency would provide one spacecraft each, to be launched in tandem by the Space Shuttle in early 1983. The arrows indicate material that comes from the Sun's polar regions and affects the ecliptic plane, and thus the Earth's environment in ways not clearly understood at this time.

Editor's Note: A line was inadvertently left out of the article on Kenneth R. Chapman, page 4, February NASA *Activities*. Second paragraph should read ". . . in matters concerned with public affairs, the legislative . . ."

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Astronaut Candidates Selected

NASA Administrator Dr. Robert A. Frosch recently announced the selection of 35 new astronaut candidates for the Space Shuttle program. The group will report to the Johnson Space Center July 1, 1978, where they will join the astronauts currently on flight status.

In making the announcement, Dr. Frosch said: "The long and difficult task of selecting the most qualified candidates for the Space Shuttle program has been concluded and we are very pleased with the results. We have selected an outstanding group which represents the most competent, talented and experienced people available to us today."

NASA received 8,079 applications during a year-long recruiting period which ended June 30, 1977. Since August, 208 finalists have been interviewed and have undergone medical examinations at the Johnson center.

After two years of training and evaluation there, successful candidates will become astronauts and enter the Shuttle training program leading to selection on a Space Shuttle flight crew.

Those chosen as pilots will operate the Space Shuttle orbiter, maneuvering it in Earth orbit and flying it to Earth for a runway landing. Mission specialist astronauts will be responsible for the coordination, with the commander and pilot, of Space Shuttle operations involving crew activity planning, the use of consumables, and other Space Shuttle activities affecting experiment operations. They may participate in extravehicular activities (space walks), perform special payload handling or maintenance operations using the Space Shuttle remote manipulator system, and assist in specific experiment operation at the discretion of sponsors of given experiments.

The newly selected candidates include 14 civilians and 21 military officers. Of the group, six are women, and four are members of minority groups. Currently there are 27 astronauts on active status (17 pilots and 10 scientist astronauts) and one on leave of absence.

The new astronaut candidates are:

Maj. Guion S. Bluford, 35, Air Force engineering specialist, from Dayton, Ohio

Lt. Cdr. Daniel C. Brandenstein, 35, Navy pilot, of Oak Harbor, Wash.

Capt. James F. Buchli, Marine, 32, of Lexington Park, Md.

Lt. Cdr. Michael L. Coats, Navy pilot, of Great Mills, Md.

Maj. Richard O. Covey, Air Force Pilot, 32, of Fort Walton Beach, Fla.

Lt. Cdr. John O. Creighton, 32, Navy pilot, of Lexington Park, Md.

Maj. John M. Fabian, 39, Air Force astronautical engineer, of Colorado Springs.

Dr. Anna L. Fisher, 28, a physician, of Rancho Palos Verdes, Calif.

First American Women Chosen as Astronaut Candidates—The six mission specialist/astronaut candidates recently chosen for two years of training (to begin in July of this year) for possible duty aboard NASA's Space Shuttle. The six women, posed behind a model of the Space Shuttle orbiter, are (l. to r.): Seddon, Fisher, Resnik, Lucid, Ride, and Sullivan.

Lt. Dale A. Gardner, 30, Navy physician, of Camarillo, Calif.

Lt. Robert L. Gibson, 31, Navy pilot, of Leonardtown, Md.

Maj. Frederick D. Gregory, 37, Air Force pilot, now attending the Armed Forces Staff College in Norfolk, Va.

Stanley D. Griggs, 38, NASA engineer, of Seabrook, Texas.

Terry J. Hart, 31, Bell Telephone Laboratories engineer, of Long Valley, N.J.

Cdr. Frederick H. Hauck, 36, Navy pilot, of Oak Harbor, Wash.

Dr. Steven A. Hawley, 27, astronomer, of Santa Cruz, Calif.

Dr. Jeffrey A. Hoffman, 34, astrophysicist at the Mass. Institute of Technology.

Dr. Shannon W. Lucid, 35, biochemist, of Oklahoma City.

Lt. Cdr. Jon A. McBride, 34, Navy pilot, of Edwards, Calif.

First Black Astronaut Candidates—McNair (left), Gregory and Bluford will soon start intensive training for their important roles in Space Shuttle work at the Johnson Space Center.

Five More New Astronaut Selectees—Meeting newsmen at the Johnson center are (l. to r.) Shriver, Nagel, Hauck, Shaw and Onisuka.

Dr. Ronald E. McNair, 27, physicist at the Hughes Research Laboratories, Malibu, Calif.

Capt. Richard M. Mullane, 32, Air Force engineer, of Fort Walton Beach, Fla.

Capt. Steven R. Nagel, 31, Air Force pilot, of Edwards, Calif.

Dr. George D. Nelson, 27, astronomer at the University of Washington, Seattle.

Capt. Ellison S. Onizuka, 31, Air Force engineer from Kealakekua, Hawaii.

Dr. Judith A. Resnick, 28, electrical engineer, Xerox Corp., El Segundo, Calif.

Sally K. Ride, 27, researcher at Stanford University, Calif.

Maj. Francis R. Scobee, 38, Air Force pilot, of Edwards, Calif.

Dr. Margaret R. Seddon, 30, surgical resident at the Memphis City Hospital, Tenn.

Capt. Brewster H. Shaw, 32, Air Force pilot, of Edwards, Calif.

Capt. Loren J. Shriver, 33, Air Force pilot, of Edwards, Calif.

Maj. Robert L. Stewart, 35, Army aeronautical engineer, of Edwards, Calif.

Kathryn D. Sullivan, 26, geologist, of Cupertino, Calif.

Dr. Norman E. Thagard, 34, a physician, of James Island, S.C.

Dr. James D. van Hoften, 33, engineer, of Houston, Texas.

Lt. Cdr. David M. Walker, 33, Navy pilot, of Virginia Beach, Va.

Lt. Cdr. Donald E. Williams, 36, Navy pilot, of Lemoore, Calif.

Living Organisms Found in Antarctic Rocks

Scientists working for NASA and the National Science Foundation have discovered living organisms hidden inside rocks in the frozen deserts of the Antarctic. The discovery—made in the Dry Valleys, a region whose harsh climate resembles conditions found on Mars—significantly extends the known limits of life on Earth, and also carries important implications for the search for extraterrestrial life.

The discovery was made by Dr. E. Imre Friedmann and Dr. Roseli Ocampo-Friedmann of Florida State University at Tallahassee, a husband-and-wife team which has been searching for microbial life in rocks for more than 15 years.

The newly-discovered microorganisms—bacteria, algae and fungi—have been isolated and are growing in laboratory cultures, where they are being studied for clues to the secret of their endurance.

The Friedmanns had found living cells inside rocks in the hot desert areas of America, Asia and Africa, but the Dry Valleys of Antarctica have long been regarded as lifeless. No plant or animal life is visible on the bare cliffs, and microbiological investigations of the soil—as well as theoretical investigations—indicated that they lack any native microbial life.

Although part of the "White Continent," the Dry Valleys region of the Antarctic is generally free of snow and ice, the combination of dryness and cold—along with the nearly constantly blowing winds—results in one of the world's harshest environments. In this frozen brown desert, mountain ranges as high as 2,400 meters alternate with valley floors, some of which contain permanently frozen lakes of high salt content.

The Friedmanns found that, far from being lifeless, the Dry Valleys have a widespread rich microbial vegetation under the surface of rocks, in the air spaces of porous rocks or in fissures. When the rocks are broken open, the organisms are seen as a dark greenish layer, a few millimeters deep.

They said that the tiny organisms take refuge from an unfavorable climate by occupying a microscopic niche where favorable conditions for life prevail, adding: "The microclimate between the minute grains of the rock may be quite different from the macro-climate outside."

The organisms colonize light-colored semi-translucent rocks into which the intensive Antarctic sunlight penetrates several millimeters deep. Thus, while the temperature outside (and on the surface of the rock) may be well below freezing, inside the rock it may rise to relatively comfortable levels. The penetrating

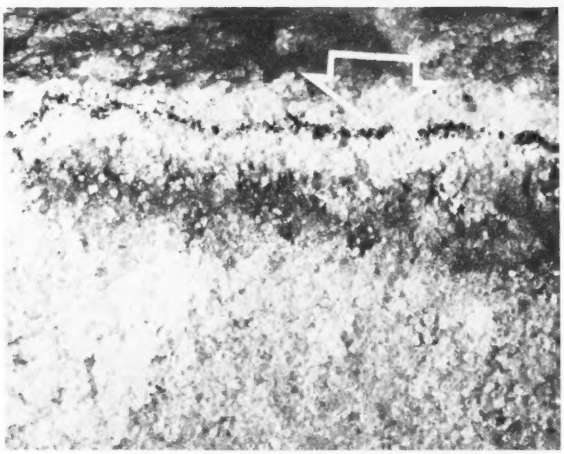
Lifeless Rocks? Perhaps Not—A rich microbial growth was found to exist within these bare and outwardly lifeless rocks, which are near the sandstone cliffs in the frozen Dry Valleys region of Antarctica.

sunlight also provides energy for photosynthesis, while the uppermost rock layer protects the microorganisms from damage caused by excessive radiation and drying up, the Friedmanns said. They pointed out that wherever the "proper" rock types occur, they are probably colonized by microbes, algae or fungi.

Dr. Richard S. Young, NASA's chief of planetary biology, noted that the Dry Valleys in many ways approach the environmental extremes found on Mars by the 1976 Viking landers. The landers searched the Martian soil for signs of microbial life and organic molecules, apparently without success.

"If Martian life forms exist only in the interior of Martian rocks, as is principally the case in the Antarctic, that could easily serve as an explanation for the lack of evidence on Mars," said Young. "Viking could not break open rocks and analyze the interiors."

He continued: "This interesting (if speculative) analogy is of considerable interest to NASA in designing future attempts to study planetary surfaces for evidence of life. If under these conditions of environment, life is most likely to reside in the interiors of certain rock types, the design of the spacecraft would be influenced accordingly. For example, we would search out specific rock types and design a sampler that can open such rocks and provide subsurface samples which can be examined for life forms and organic molecules. This would lead to quite a different mission sequence from Viking's."



Life Inside a Rock—Magnified about 10 times, this broken sandstone rock from the Dry Valleys region of the Antarctic was found to be teeming with living microbes, algae and fungi. The life forms appear as a dark line about one-fortieth of an inch under the surface (see arrow). The region in which the rock was found resembles parts of the Martian landscape.

The Friedmanns expect that studies of the newly discovered life forms now under way will yield further information on their distribution and way of life. Their work was supported by research grants provided by NASA and NSF.

U.S.-Soviet Spacecraft Experiments Discussed

NASA and the USSR Academy of Sciences have confirmed the summaries of results of meetings held between the two agencies in November. One meeting, held in Moscow, Nov. 14 through 17, concerned possible cooperative scientific experiments using the U.S. Shuttle and the Soviet Salyut spacecraft. At the other meetings, held at Wallops Islands, Nov. 19 through 25 and in Bethesda, Nov. 16 through 18, experiments flown on a recent Soviet biosatellite as well as proposals for future biosatellite missions and medical results of manned space flight were discussed.

In Moscow the two agencies talked about preliminary scientific proposals and scientific experimental measures that might benefit from a long duration station of the Salyut type and a reusable Shuttle spacecraft. The joint working group for basic and applied scientific experiments preliminarily considered the following scientific proposals which could be carried out within the framework of a Shuttle/Salyut program:

(1) Radio astronomy experiments using an aperture synthesis system.
(2) Infrared interferometry.
(3) X-ray astronomy.
(4) Gamma-ray astronomy.
(5) Cosmic ray research.
(6) Research on physical conditions in active regions of the sun.
(7) Space biology and medicine.
(8) Laser absorption spectroscopy for studying pollution of the upper atmosphere.
(9) Radio sounding for radiophysical investigation of the Earth's atmosphere.
(10) Space processing.
(11) Active (controlled) experiments in the Earth's magnetosphere and ionosphere.
(12) Space meteorology and study of earth resources.

Concerning those proposals, a common interest was expressed at the time in the following research areas:

- High energy astrophysics (gamma-ray astronomy, X-ray astronomy and cosmic rays);
- Atmospheric research;

- Active experiments in the magnetosphere and ionosphere;
- Medical and biological experiments;
- Radio astronomy.

The joint working groups agreed to meet in the United States in late March or early April, in Moscow in July, and again in the U.S. in October 1978.

At the Bethesda and Wallops Island meetings representatives discussed information on experience gained in manned space flight programs, in particular, the Salyut 5/Soyuz 21 and 24 missions. Also discussed were preliminary results from U.S. and Soviet experiments flown on Cosmos 936 in August 1977. The USSR invited the U.S. to participate in Soviet biosatellite flights in 1980 and 1981.

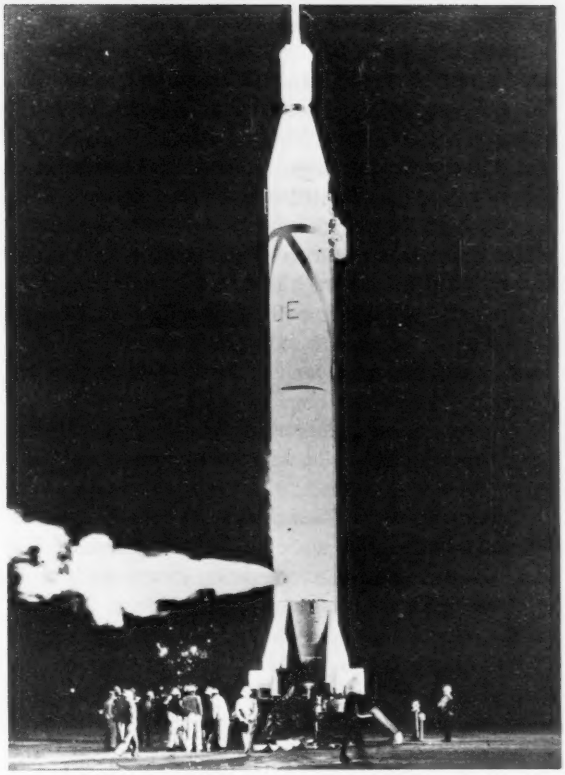
A ninth meeting of the space biology and medicine working group will be held in the USSR in the second half of 1978. The talks are being held as part of ongoing activities to be conducted under the U.S.-Soviet Space Cooperation Agreement.

Historical Look at Beginning of Space Age in U.S.

America's first artificial Earth satellite, Explorer 1, was launched 20 years ago last Jan. 31. The 13.9 kilogram object, shaped like a stovepipe, 15.2 centimeters in diameter and 203.2 cm long, ushered the U.S. and the western world into the age of space. The principal scientific achievement of Explorer 1 was a major one—the discovery of the Van Allen radiation belts surrounding Earth. The anniversary of the launch was celebrated in ceremonies at several NASA centers and by headquarters personnel at social events at the National Air and Space Museum and the National Academy of Science.

Explorer 1 was prepared and launched by two Army organizations which are now elements of NASA: the development group of the Army Ballistic Missile Agency (ABMA), Huntsville, Ala., and the Jet Propulsion Laboratory. The development group of ABMA was transferred to NASA and became the nucleus of the new Marshall Space Flight Center in 1960. Some 1,400 employees who helped launch Explorer 1 still work at the Marshall center. JPL was assigned to the space agency in December 1958. Two thousand workers were on the JPL roster in 1958, compared with 4,000 now.

ABMA provided the modified Redstone booster and the basic satellite design, while JPL furnished the solid propellant upper stages of the carrier vehicle and packaged and tested the payload.



First U.S. Spacecraft—The Jupiter-C rocket on the launch pad at Cape Canaveral, ready to launch Explorer 1 into Earth orbit. The historic event took place on Jan. 31, 1958.

Explorer 1's launch from Cape Canaveral by a Jupiter C vehicle came at 10:48 p.m. EST, Jan. 31, 1958, 84 days after the Department of Defense gave the Army group the go-ahead to prepare the orbiter as a backup to the existing Vanguard satellite project. On orders from the White House, the event was shrouded in secrecy until verification of the fact that the satellite had reached its orbit. At the time, there were two Soviet Sputniks in orbit.

The small satellite dispatched information on the space environment to Earth stations until May 23, 1958, when its batteries were exhausted. The vehicle, however, continued to orbit for several years. It reentered March 31, 1970.

The project that culminated in the launch of the Explorer 1 satellite actually had its beginning several years earlier. As early as 1954, the rocket group at Huntsville, led by the late Dr. Wernher von Braun, had proposed orbiting a satellite with available missile hardware.

The proposed multi-stage vehicle would have a Redstone missile as the first stage and would carry solid-propelled upper stages. JPL and the Office of Naval Research joined the fledgling program, to be called "Project Orbiter." But "Project Vanguard," a Naval Research Laboratory/National Acadamy of Sciences program, was selected as the nation's satellite program and the orbiter was shelved. Although the orbiter proposal was turned down, work did not stop entirely on the multi-stage launch vehicle.

The same combination of a multi-stage vehicle was needed at the time for testing reentry nosecones to be used on ballistic missiles. The von Braun group used the proposed vehicle, called the Jupiter C (composite reentry test vehicle), to develop ablative type materials for war heads that could withstand extremely high reentry heat.

The third Jupiter C launched in the reentry heat test series sent a one-third scale model nosecone into space Aug. 8, 1957. The object was recovered from the Atlantic Ocean by the Navy after a flight of 1,930 kilometers with a peak altitude of more than 966 km. This was the first U.S. manmade object recovered from outer space and the flight proved the feasibility of the ablative-type nosecone.

During the mid-1950's, Marshall center engineers and scientists did some design work and modest development work on a satellite. The late Josef Boehm, who worked then in the guidance section and later in the center's Astrionics Laboratory, designed a complete satellite in 1954.

The unofficial satellite program had reached a point by early 1957 at which time a plan was in operation for a satellite tracking computer and data gathering system.

Development problems slowed the Vanguard project and in the wake of the first two Russian Sputnik launchings, the Army was told to be ready to put an American satellite into space. When the Defense Department's Nov. 8, 1957 order came, all that was needed to start things rolling was to fabricate the satellite and assemble the Redstone solid-fuel rocket assembly for the launch vehicle.

JPL fabricated the satellite designed by Boehm. The primary difference between Boehm's proposed satellite and the JPL version was that the cylindrical device was made from metal instead of fiberglass as proposed by Boehm. JPL also provided the solid upper stages. Dr. William H. Pickering, JPL director (now retired) led the Explorer team in the 84-day catch-up endeavor. Dr. Jack Froelich was manager of the project and Dr. Albert Hibbs was project scientist at JPL. Launch operations at the Cape were conducted by Dr. Kurt H. Debus.

Dr. James Van Allen, of the State University of Iowa, designed the scientific package carried into space, which detected the radiation belt that now bears his name. The Explorer 1 launch was part of this country's participation in the International Geophysical Year.

Galileo: A Fantastic Journey

Project Galileo is the new name of NASA's major exploration mission to the outer planets in the early 1980s. Formerly known as JOP, or Jupiter Orbiter Probe, the Galileo spacecraft will reach the giant planet in 1985. Even now, scientists and engineers at NASA's Jet Propulsion Laboratory and at the Ames Research Center, along with many others in universities, in industry and from five other countries are at work on the program.

The name Galileo honors Galileo Galilei, the 16th century Italian astronomer and physicist who was the first to observe the planets through a telescope and who discovered the moons of Jupiter. The Galileo mission will contribute greatly to our efforts to understand the origin and evolution of the solar system.

Other NASA spacecraft are paving the way to Jupiter on flyby missions: Pioneers 10 and 11 in 1973-74, and the twin Voyager spacecraft launched last year, will study the planet at close range in 1979. Focus of interest on Jupiter is well justified—like its namesake, the king of the Roman gods, this huge planet dominates the planetary system. Its diameter is 10 times that of Earth, and it contains more matter than all the other planets put together. With its 14 moons, four of which are as large as many planets, Jupiter is actually the center of a miniature solar system like the Sun and planets.

Jupiter is a mysterious world, a giant globe with no apparent solid surface, composed largely of hydrogen and helium. It may represent the original "star-stuff" from which the Sun and all planets were formed; a probe of the atmosphere of Jupiter will tell us much more than we now know about the Sun and the planetary system.

Jupiter has its own internal energy source, radiating twice as much energy as it receives from the Sun. Like the mysterious pulsars, it is surrounded by a vast, rapidly spinning magnetosphere and by belts of high-energy particles. Jupiter's atmosphere is driven by the same forces that act on the

atmosphere of Earth, but on a much larger scale—major cyclones like the Great Red Spot are thousands of miles across and persist for centuries, and Jupiter's atmosphere contains multiple cloud layers, each with its own temperature and chemical composition.

The four large moons of Jupiter— Io, Europa, Ganymede, and Callisto—make up a varied and fascinating microcosm of unique worlds. Some are composed largely of rock, some of ice, some of water. Their surfaces probably run the gamut from lunar-like cratered plains to salt-covered beds of extinct seas to exotic landforms created of ice and mud. On Io, bombardment of the surface by a heavy hail of radiation releases sodium and creates a tenuous metallic atmosphere.

The Galileo spacecraft has an entry probe that will plunge deep into the planet's atmosphere, measuring the chemistry and structure as it descends; and an orbiting spacecraft that will explore near-Jupiter space for two years after the probe is released. The orbiter has a spinning section to study Jupiter's magnetosphere and radiation belts, and a stabilized section from which high-resolution photography and remote sensing observations can be made of the planet and its satellites.

Galileo is scheduled for launch by the Space Shuttle in January 1982. The Shuttle capability, combined with an unusually favorable launch opportunity, allows this comprehensive combined probe-and-orbiter mission to be carried out with a single launch. Enroute to Jupiter, the spacecraft will make a close flyby of Mars, gaining speed for the long trip to Jupiter, 644 million kilometers from Earth. Though it will arrive in July 1985, the orbiter may still be returning data a decade from now.

As the Galileo probe enters the atmosphere of Jupiter, it will be braked by atmospheric friction and then by a small parachute. Six instruments to investigate chemical composition, structure, cloud particles, energy balance, and circulation of the atmosphere will transmit data for about 45 minutes as the probe descends. Radio contact will be lost as it sinks deeper into regions of crushing pressure and oven-hot temperatures, hundreds of miles below the icy clouds we see from Earth.

The orbiter section of the spacecraft contains 10 scientific instruments to study dynamics of the planet's atmosphere, to explore the nature and behavior of its magnetosphere, and to investigate the composition, geology, atmosphere, and gravitational and magnetic fields of the moons.

The NASA/Galileo team includes 110 scientists from the U.S., Canada, Germany, France, Sweden and the Netherlands. Construction of the orbiter spacecraft, together with overall mission management responsibility, rests with NASA's Jet Propulsion Laboratory, and the Ames center has responsibility for the probe. The Federal Republic of Germany, in a cooperative agreement with NASA, is providing the retropropulsion engine that will inject the Galileo spacecraft into orbit around Jupiter, and the U.S. Department of Energy is developing a new nuclear power system for the spacecraft.

Galileo will be the first planetary spacecraft to be launched by the Space Shuttle, and the first to use the intertial upper stage. It also will be the first direct probe of a giant planet, and the first spacecraft to orbit a giant planet. In addition to expanding our understanding of the many facets of Jupiter, Galileo will serve as a prototype for an orbiter and probe of the ringed planet, Saturn, to be studied in the late 1980s.

Continuing Thunderstorm Research

Study of the electrical properties of thunderstorms conducted at the Kennedy Space Center during the past two summers will continue in 1978.

The study, known as the Thunderstorm Research International Program, involves combined efforts of the top atmospheric physicists and lightning researchers in the United States, and investigators from Europe and Africa, in studies of the electrical characteristics of thunderstorms—how they came into being in the first place and what happens thereafter.

An invitation for the researchers to return to KSC in 1978 was extended at the recent annual fall meeting of the American Geophysical Union in San Francisco.

This is the third consecutive year in which KSC will play host to the program, whose researchers use the center's unique meteorological facilities built up during the Apollo and Skylab programs to study the large number of summer thunderstorms that occur in the Florida region.

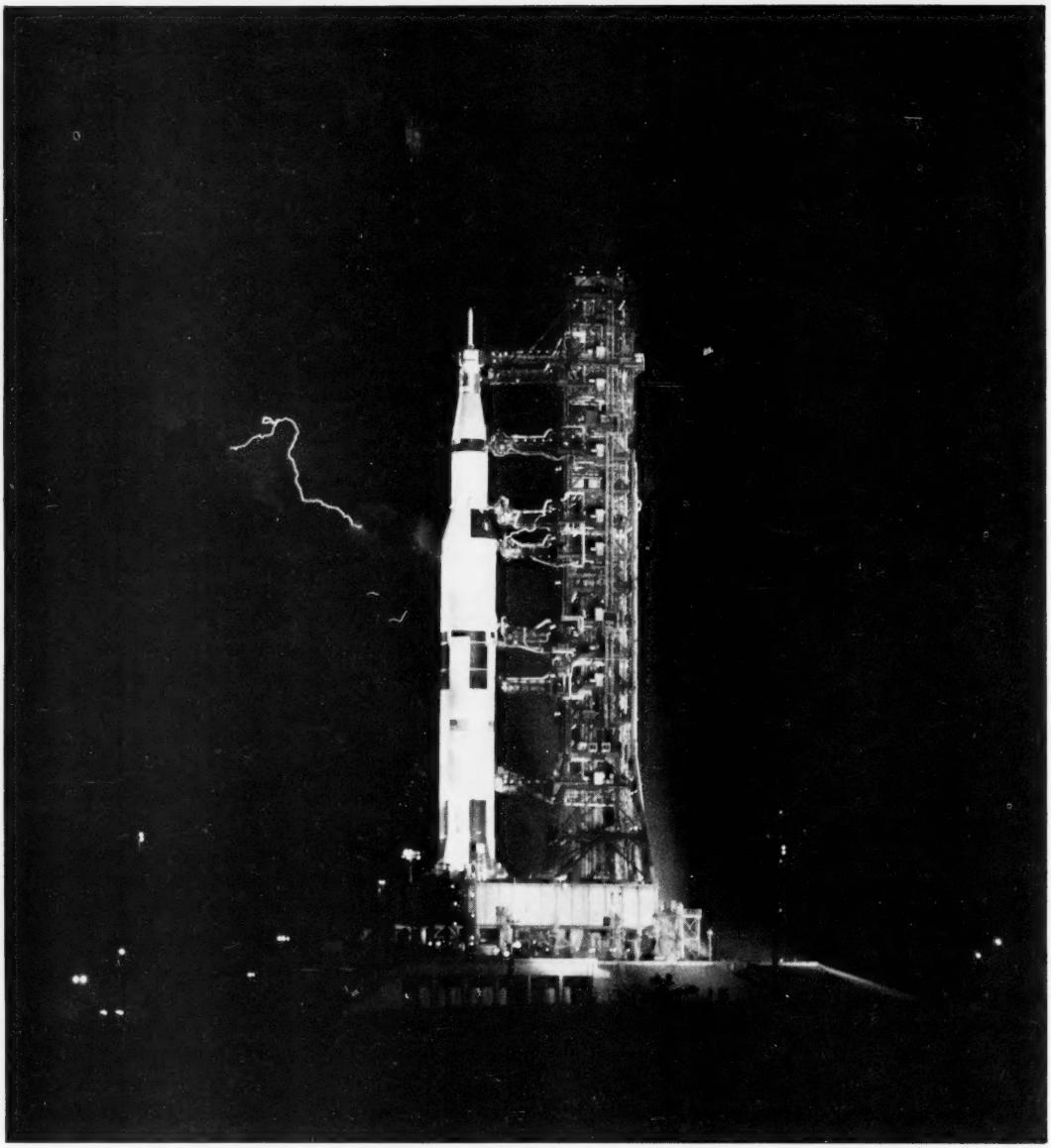
The researchers fund their own programs and KSC provides its meteorological instrumentation, facilities of the local National Weather Service office and normally available support services such as power, communications and film processing.

Having many investigators in the same area studying the same storms and exchanging data offers the chance of gaining more knowledge than might be

achieved through isolated studies. The last two years of the program have borne out that concept.

The spaceport also is benefitting from the program inasmuch as what is being learned will be applied in future Space Shuttle launch and landing operations.

Although KSC is not scheduled to be the setting for the research group after 1978, the program will not end. The 1979 study site will be the Langmuir Laboratories, Socorro, N.M., to assess mountain storms of the southwest.



Near Miss—During the Apollo 15 launch in 1971, lightning struck near the launch pad during prelaunch preparations. Studies underway seek to find answers to problems caused by the many severe storms that occur in Florida during summer and fall.

Airfoil Design Center Now Operational

NASA has certified as fully operational the General Aviation Airfoil Design and Analysis Center (ADAC) at Ohio State University Airport, Columbus, Ohio. ADAC provides services directly to aircraft designers and manufacturers, including analysis and design of two dimensional airfoil shapes, analytical investigation of high lift devices and aerodynamic controls, compilation of airfoil aerodynamic characteristics and technical assistance and consultation for airfoil wind tunnel and flight testing.

The services are provided to industry on a fee charge basis. ADAC was developed under a contract between NASA's Langley Research Center, and Ohio State University's Aeronautical and Astronautical Research Laboratory.

Under a three-year contract, personnel at the university laboratory will work closely with NASA personnel to refine existing computational codes for analytic treatment of two-dimensional airfoils. As new techniques and improved computation codes are developel by NASA, they will be refined by the laboratory for effective use in solving difficult and complex airfoil problems.

Dr. G. M. Gregorek is director of ADAK and Dr. R. W. Barnwell of the staff of the Langley center is the contract monitor.

Clear Air Turbulence May Be Detectable

Scientists from NASA's Ames Research Center and the National Oceanic and Atmospheric Administration's (NOAA) Environmental Research Laboratory in Boulder, Colo., will begin flight testing this month on an instrument concept designed to give pilots several minutes warning of an impending encounter with clear air turbulence, a natural occurrence.

The atmospheric phenomenon, known at CAT, which features tempestuous air currents, has been a problem since the beginning of the jet age. The currents can add unexpected bumps to an aircraft's smooth ride even though the sky may be cloudless. The pilot has no way of detecting the condition and has no indication of when or where it mighe be encountered. Needed is a simple, reliable cockpit instrument to alert pilots as they approach CAT.

The CAT detector to be tested uses an infrared water vapor radiometer to measure the amount of moisture present in the atmosphere. Its development as a potential aid to pilots came about as a result of observations made by NOAA scientist Dr. Peter Kuhn, an experimenter on NASA's Gerard P. Kuiper observatory. The observatory is a C-141 aircraft equipped with a large telescope for astronomy research. Kuhn noticed that extreme turbulence encountered by the the aircraft was often accompanied by variations in the amount of water vapor in the atmosphere as measured by his infrared radiometer.

At the time, the instrument was used for the measurement of amounts of water vapor in the atmosphere *above* the aircraft so that atmospheric conditions in the telescope's field of view could be defined. Dr. Kuhn, intrigued with the idea that it might be possible to "see" areas of turbulence ahead of an aircraft, suggested mounting another radiometer in the aircraft, this time aimed in a forward direction.

The forward-looking system successfully detected turbulence. With the help of a simple program in the computer aboard the research aircraft, CAT occurrences were predicted from 2½ to 5½ minutes before actual encounter. Clear air turbulence was detectable once water vapor discontinuities in the air ahead of an airplane had been identified.

But problems remained. Because the mission of the C-141 aircraft requires highly accurate flight paths through the cold stratosphere, opportunities were virtually non-existent to purposely search out CAT areas and to fly into them from different directions at various altitudes. Moreover, the researchers wanted to experiment with filters that could change the "look" distance to the encounter and provide information on the depth of the disturbance. They also wanted more time to refine the instrument for optimum results and to minimize the false alarm rate present in such a system.

Accordingly, NASA and NOAA established a joint program, involving conducting extensive tests on the device after it had been mounted on a NASA Lear Jet research aircraft. Research flights began in January over Colorado, flying from a base at the Denver Stapleton International Airport.

Researchers hope the flight program will lead to development of a low cost system which can be installed in any aircraft to operate unattended and require minimum maintenance service. If its efficiency is proven, the device will produce a cockpit visual alert 4 to 15 minutes in advance of a CAT encounter.

Such an instrument could enhance safety and comfort of flight by giving pilots warning of imminent turbulence encounters, allowing time for the flight and cabin crews to prepare for turbulence or possibly to avoid turbulent areas.

NASA Budget Plan for Fiscal Year 1978
(Figures submitted to the Congress)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

BUDGET SUMMARY
(Thousands of Dollars)

BUDGET PLAN	FY 1977	FY 1978	FY 1979
Research and development	2,883,425	3,011,600	3,305,100
Construction of facilities	118,090	162,340	152,500
Research and program management	844,361	890,200[a]	914,000
TOTAL BUDGET PLAN	3,845,876	4,064,140	4,371,600
OUTLAYS	3,945,311	3,981,600	4,270,100

[a] Includes proposed supplemental of $46,200,000 to cover increased salary rates

National Aeronautics and Space Administration

SPACE TRANSPORTATION SYSTEMS

BUDGET PLAN
(Thousands of Dollars)

	FY 1977	FY 1978	FY 1979
SPACE SHUTTLE	1,413,100	1,349,200	1,439,300
Design, Development, Test and Evaluation	(1,343,100)	(1,307,500)	(985,300)
Orbiter	899,400	800,500	536,500
Main engine	182,200	219,900	176,700
External tanks	84,000	82,200	80,500
Solid rocket boosters	100,400	97,300	63,500
Launch and landing	77,100	107,600	128,100
Production	(70,000)	41,700)	(454,000)
Orbiter	65,000	38,700	397,000
Main engine	5,000	3,000	18,000
Launch and landing	---	---	11,000
Spares and equipment	---	---	28,000
SPACE FLIGHT OPERATIONS	199,200	267,800	311,900
Space transportation system operations capability development	16,800	59,700	110,500
Development, test and mission operations	166,900	176,400	163,000
Advanced programs	12,000	10,000	5,000
Space transportation system operations	---	17,700	33,400
Planning and program integration	4,500	4,000	---
EXPENDABLE LAUNCH VEHICLES	151,400	134,500	76,500
Scout	10,700	17,000	11,900
Centaur	84,000	55,900	21,300
Delta	44,900	55,300	38,600
Atlas-F	11,800	6,300	---
TOTAL SPACE TRANSPORTATION SYSTEMS	1,763,700	1,751,500	1,827,700

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

RESEARCH AND DEVELOPMENT PROGRAMS

BUDGET PLAN
(Thousands of Dollars)

Cognizant Office and Program	FY 1977	FY 1978	FY 1979
SPACE TRANSPORTATION SYSTEMS	1,763,700	1,751,500	1,827,700
Space shuttle	1,413,100	1,349,200	1,439,300
Space flight operations	199,200	267,800	311,900
Expendable launch vehicles	151,400	134,500	76,500
SPACE SCIENCES	380,325	404,700	513,200
Physics and astronomy	166,300	224,200	285,500
Lunar and planetary exploration	191,900	147,200	187,100
Life Sciences	22,125	33,300	40,600
SPACE AND TERRESTRIAL APPLICATIONS	206,300	243,900	283,400
Space applications	198,200	234,800	274,300
Technology utilization	8,100	9,100	9,100
AERONAUTICS AND SPACE TECHNOLOGY	278,100	333,200	375,400
Aeronautical research and technology	190,100	228,000	264,100
Space research and technology	82,000	97,700	108,300
Energy technology applications	6,000	7,500	3,000
SPACE TRACKING AND DATA SYSTEMS	255,000	278,300	305,400
TOTAL	2,883,425	3,011,600	3,305,100

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SPACE SCIENCE

BUDGET PLAN
(Thousands of Dollars)

	FY 1977	FY 1978	FY 1979
PHYSICS AND ASTRONOMY	166,300	224,200	285,500
High energy astronomy observatory	39,362	18,400	11,400
Solar maximum mission	21,300	30,600	16,200
Space telescope development	--	36,000	79,200
Solar polar mission development	--	--	13,000
Shuttle/Spacelab payload development	6,000	28,900	38,300
Explorer development	23,441	23,896	29,800
Mission operations and data analysis	19,397	27,004	32,400
Research and analysis	30,800	33,400	35,900
Suborbital programs	26,000	26,000	29,300
LUNAR AND PLANETARY EXPLORATION	191,900	147,200	187,100
Pioneer Venus	42,800	18,100	--
Voyager	50,300	--	--
Jupiter orbiter/probe	--	20,700	78,700
Mission operations and data analysis	77,848	84,500	84,400
Research and analysis	20,952	23,900	24,000
LIFE SCIENCES	22,125	33,300	40,600
Life sciences flight experiments	1,500	9,000	12,400
Vestibular function research	900	1,500	3,800
Research and analysis	19,725	22,800	24,400
TOTAL SPACE SCIENCE	380,325	404,700	513,200

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SPACE AND TERRESTRIAL APPLICATIONS

BUDGET PLAN
(Thousands of Dollars)

	FY 1977	FY 1978	FY 1979
SPACE APPLICATIONS:	198,200	234,800	274,300
EARTH RESOURCES DETECTION AND MONITORING	(75,362)	(106,945)	(151,500)
Landsat-C	13,500	3,200	700
Landsat-D	6,000	48,200	97,500
Shuttle/spacelab payload development	1,000	3,370	6,000
Shuttle/spacelab mission design and integration	---	2,240	6,900
Integrated payload planning	(3,500)	(4,000)	4,000
Applications research and technology development	53,162	49,735	36,400
Follow-on data analysis and operations	1,700	200	---
EARTH DYNAMICS MONITORING AND FORECASTING	(4,950)	(7,200)	(8,600)
Tectonic plate motion	1,890	2,200	2,100
Applications research and technology development	1,625	3,100	5,400
Follow-on data analysis and operations	1,435	1,900	1,100
OCEAN CONDITION MONITORING AND FORECASTING	(30,890)	(16,950)	(12,400)
Seasat-A	28,090	11,400	3,000
Applications research and technology development	1,100	2,750	4,200
Follow-on data analysis and operations	1,700	2,800	5,200
ENVIRONMENTAL QUALITY MONITORING	(24,101)	(26,190)	(20,200)
Nimbus-G	15,400	13,900	2,800
Halogen occultation experiment	---	---	6,100
Shuttle/spacelab payload development	800	3,140	2,900
Applications research and technology development	7,901	8,150	7,400
Follow-on data analysis and operations	---	1,000	1,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SPACE AND TERRESTRIAL APPLICATIONS (CONT'D)

BUDGET PLAN
(Thousands of Dollars)

	FY 1977	FY 1978	FY 1979
WEATHER OBSERVATION AND FORECASTING	(29,955)	(25,115)	(22,800)
Tiros-N	10,100	4,100	---
Shuttle/spacelab payload development (ACPL)	---	2,700	4,400
Global atmospheric research program	5,056	5,000	5,800
Severe storm research program	6,100	5,600	6,500
Global weather program support	7,099	5,815	5,100
Follow-on data analysis and operations	1,600	1,900	1,000
CLIMATE RESEARCH	(600)	(2,500)	(12,200)
Earth radiation budget satellite system	---	---	8,000
Applications research and technology development	600	2,500	4,200
MATERIALS PROCESSING IN SPACE	(8,090)	(15,200)	(20,400)
Space processing applications rocket project	2,900	3,900	3,600
Applications research and technology development	5,190	5,000	4,400
Shuttle/spacelab payload development	---	6,300	12,400
SPACE COMMUNICATIONS	(15,252)	(21,200)	(22,000)
Search and rescue mission	---	5,600	8,000
Shuttle/spacelab payload development	700	1,000	1,200
Technical consultation and support studies	2,580	3,100	3,100
Application Research and technology development	8,002	7,700	5,200
Follow-on data analysis and operations	3,700	3,700	4,500
Cooperative applications satellite-C	300	100	---

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SPACE AND TERRESTRIAL APPLICATIONS (CONT'D)

BUDGET PLAN
(Thousands of Dollars)

	FY 1977	FY 1978	FY 1979
APPLICATIONS EXPLORER MISSIONS	(9,000)	(13,500)	(4,200)
Heat capacity mapping mission	1,700	600	300
Stratospheric aerosol and gas experiment	4,100	2,400	---
Magnetic field satellite	3,200	10,500	3,900
TECHNOLOGY UTILIZATION:	8,100	9,100	9,100
Industrial applications	3,445	3,715	3,715
Technology applications	3,640	4,110	4,110
Program control and evaluation	1,015	1,275	1,275
TOTAL SPACE AND TERRESTRIAL APPLICATIONS	206,300	243,900	283,400

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

AERONAUTICS AND SPACE TECHNOLOGY

BUDGET PLAN
(Thousands of Dollars)

	FY 1977	FY 1978	FY 1979
AERONAUTICAL RESEARCH AND TECHNOLOGY	190,100	228,000	264,100
Research and technology base	90,706	98,660	109,200
Systems studies	2,966	3,000	3,000
Systems technology programs	60,838	75,090	85,645
Experimental programs	35,590	51,250	66,255
(Aircraft energy efficiency technology included in systems technology and experimental programs)	(39,715)	(70,200)	(97,400)
SPACE RESEARCH AND TECHNOLOGY	82,000	97,700	108,300
Research and technology base	60,610	65,900	71,700
Systems studies	2,000	2,000	2,000
Systems technology programs	3,080	5,800	7,900
Experimental programs	8,010	15,000	17,700
Low cost systems program	8,300	9,000	9,000
ENERGY TECHNOLOGY APPLICATIONS	6,000	7,500	3,000
TOTAL AERONAUTICS AND SPACE TECHNOLOGY	278,100	333,200	375,400

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SPACE TRACKING AND DATA SYSTEMS

BUDGET PLAN
(Thousands of Dollars)

	FY 1977	FY 1978	FY 1979
TRACKING AND DATA ACQUISITION	255,000	278,300	305,400
Operations	203,600	228,600	254,200
Systems implementation	42,700	40,400	41,300
Advanced systems	8,700	9,300	9,900

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1979 CONSTRUCTION OF FACILITIES PROGRAM

BUDGET PLAN
(Thousands of Dollars)

PROJECTS BY INSTALLATION

Rehabilitation and Modification of Facilities at Various Locations, Not in Excess of $500,000 per Project	17,800
Minor Construction of New Facilities and Additions to Existing Facilities at Various Locations, Not in Excess of $250,000 per Project	4,200
Facility Planning and Design	10,650
TOTAL	152,500

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1979 CONSTRUCTION OF FACILITIES PROGRAM

BUDGET PLAN
(Thousands of Dollars)

PROJECTS BY INSTALLATION

Ames Research Center	9,770
Modification of unitary plan wind tunnel	5,390
Modification of 3.5 foot wind tunnel	1,870
Modification of 12-foot pressure wind tunnel	2,510
Goddard Space Flight Center	5,640
Modifications and additions for logistic and supply functions	5,640
Jet Propulsion Laboratory	4,630
Modifications to various buildings for seismic protection	1,570
Modifications and addition to the space flight operations facility	3,060
Langley Research Center	6,500
Modifications for utility control system	1,980
Rehabilitation of unitary plan wind tunnel	4,520
Lewis Research Center	6,140
Construction of research analysis center	6,140
Large Aeronautical Facilities at Various Locations	56,100
Construction of national transonic facility (LaRC)	24,500
Modification of 40- by 80-foot subsonic wind tunnel (ARC)	31,600
Space Shuttle Facilities at Various Locations	31,070
Modifications to launch complex 39, pad B (KSC)	13,570
Modification of manufacturing and final assembly facilities for external tanks (MAF)	13,980
Modifications to solid rocket motor manufacturing and assembly facilities, Thiokol plant, Wasatch, Utah	1,920
Minor Shuttle-unique projects (various locations)	1,600

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

RESEARCH AND PROGRAM MANAGEMENT

BUDGET PLAN
(Thousands of Dollars)

INSTALLATION	FY 1977	FY 1978	FY 1979
Johnson Space Center	139,488	145,875	150,296
Kennedy Space Center, NASA	109,742	112,549	118,431
Marshall Space Flight Center	139,417	141,485	140,857
National Space Technology Laboratories	1,840	2,764	3,488
Goddard Space Flight Center	114,874	122,247	124,139
Wallops Flight Center	13,268	14,539	15,205
Ames Research Center	53,265	58,373	59,212
Dryden Flight Research Center	17,333	18,727	19,481
Langley Research Center	95,597	102,589	104,579
Lewis Research Center	83,818	90,761	93,780
NASA Headquarters	75,719	80,291	84,532
TOTAL	844,361	890,200[a]	914,000

[a] Includes proposed supplemental of $46,200,000 for increased salary rates.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

RESEARCH AND PROGRAM MANAGEMENT

TOTAL NUMBER OF PERMANENT POSITIONS

END OF YEAR

INSTALLATION	FY 1977	FY 1978	FY 1979
Johnson Space Center	3,585	3,526	3,546
Kennedy Space Center, NASA	2,230	2,186	2,207
Marshall Space Flight Center	3,910	3,760	3,715
National Space Technology Laboratories	70	100	104
Goddard Space Flight Center	3,625	3,548	3,548
Wallops Flight Center	410	408	408
Ames Research Center	1,613	1,677	1,677
Dryden Flight Research Center	515	490	490
Langley Research Center	3,135	3,069	3,069
Lewis Research Center	2,998	2,938	2,938
NASA Headquarters	1,545	1,535	1,535
TOTAL	23,636	23,237	23,237

Weatherspoon Takes on Equal Opportunity Job

Mrs. Mary E. Weatherspoon was appointed agency-wide affirmative action program coordinator for NASA's Equal Opportunity Programs early in January. Her responsibilities encompass developing, coordinating, managing and evaluating a positive and continuing program of affirmative action to insure equal opportunity regardless of race, color, sex, religion, age, or national origin. She will assess NASA-wide policy and procedures to ascertain that the concept of affirmative action is reflected in all agency programs and activities.

Before her appointment at NASA, she worked for the Department of Defense as National Deputy for Equal Opportunity and Federal Women's Program coordinator for the Army Corps of Engineers. Earlier she served as EEO officer and Federal Women's Program coordinator at the Walter Reed Army Medical Center. She also worked for 12 years in nongovernment jobs concerned with civil rights and community action, covering a wide variety of professional duties and responsibilities. She has received a number of commendations for her work in equal opportunity and community relations.

Weatherspoon holds Bachelor's and Master's degrees in political science from Howard University, with an emphasis on public administration and public policy and American political government.

Manufacture of Space Telescope Mirror Begins

Work has begun at Corning Glass Works, Canton, N.Y. on a huge primary mirror blank for NASA's space telescope—a telescope that theoretically will let astronomers see to the edge of the universe. NASA's Marshall Space Flight Center has management responsibility for the space telescope, scheduled for launch into Earth orbit in 1983.

One subject on which the telescope may shed light is the scientific belief that the universe was formed nearly 14 billion years ago. Because the telescope is expected to detect light from objects 14 billion light-years away, it might provide views of the very first galaxies at the time they were formed. The tremendous increase in power of the space telescope can be illustrated by comparing it to the famous Hale telescope at Mt. Palomar, Calif., which can penetrate only about two billion light-years away. The space observatory will orbit more than 300 miles above the Earth, after transport aloft by a NASA Space Shuttle.

Corning won the $1.74-million mirror blank contract from Perkin-Elmer Corp., which will be responsible for the optical telescope assembly. The Lockheed Missiles and Space Co. will construct the primary spacecraft structure and support system and will integrate the complete telescope.

Work is now underway by Corning on the first of two eight-foot discs for the telescope. The first is to be delivered to Perkin-Elmer in a year and the spare in April 1979. Then will come the laborious process of grinding and polishing the mirror blank to its optical curvature.

A telescope mirror blank carries a thin metal film that is the mirror or reflective surface. Glass has long been the choice as mirror blank material because it is inert and changes shape only very slightly as temperatures change during viewing, assuring image quality. More than 40 years ago, Corning made the 200-inch mirror blank for the Hale telescope with borosilicate glass, which has an expansion of 32.5 on a scale used by physicists. By comparison, the material for the space telescope mirror blank has an expansion of zero.

The mirror blank will have an aperture of approximately 238 centimeters and a center hole about 21 cm in diameter. It will be about 10 cm thick, consisting of solid top and bottom plates, each 2½ cm thick, and circumferential rings about .60 cm thick. They will be separated by a weight-saving monolithic structure of open cells approximately 25 cm long from top to bottom and 10 cm square.

The space telescope is expected to produce major advances in man's knowledge of the universe. It will let scientists investigate problems relating to the structure, origin, evolution and energy balance of the universe that could never be approached from observatories below the veil of the atmosphere. Functional in the ultraviolet, visible and infrared regions of light, it will be capable of pointing anywhere in the celestial sphere.

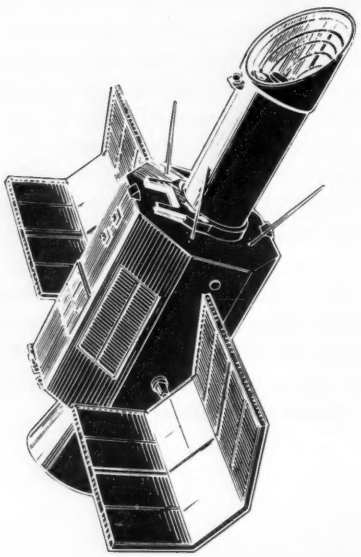
Ultraviolet Explorer Satellite Launched

NASA, in cooperation with the European Space Agency (ESA) and the British Science Research Council (SRC), launched an International Ultraviolet Explorer Jan. 26 into a modified synchronous Earth orbit to study a wide range of celestial objects in one of the most important regions of the electromagnetic spectrum. Launch was by a Delta rocket from Cape Canaveral.

Nearly 200 astronomers from 17 countries, including the Soviet Union, already have been selected to conduct observations with the IUE, making the spacecraft one of the most widely used in NASA history. Studies will range from planets in our own solar system to some of the most distant objects in the universe, including quasars, pulsars and black holes in space.

IUE will be examining the spectral region which lies in the ultraviolet (UV) between 1150 Angstroms and 3200 Angstroms, a region inaccessible from the ground. This region includes the fundamental emissions of many of the common elements in the universe (hydrogen, helium, carbon, nitrogen, oxygen).

Data returned by IUE are expected to shed more light on the nature of the different kinds of stars that populate our galaxy; on the material between the stars from which stars are formed; on many of the objects that are emitting radio waves or X-rays; and on nearby galaxies such as the little-understood Seyfert galaxies (see glossary).



Quasars are among the most puzzling objects in the universe. They are estimated to be less than 10 light years in diameter, compared with the 100,000-light-year diameter of a typical galaxy of 100 billion stars; yet quasars pour out 100 times more energy. They are the most powerful emitters of energy known. How this enormous energy is generated is a mystery. No known physical process exists to account for it.

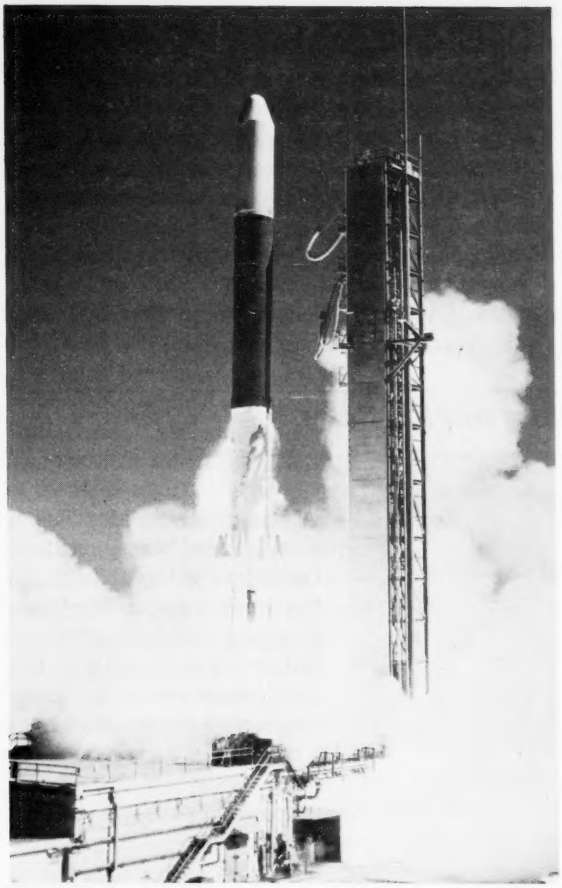
It is expected that new knowledge may be obtained by examining in detail relatively nearby quasars in the ultraviolet, and then comparing these data with those from the more distant quasars seen by ground observatories in visible light.

In our own galaxy, the spacecraft will look at hot stars and the outer atmospheres of "cool" stars. Such stars, similar to our own Sun, are relatively cool at their surfaces but have extremely rarefied outer atmospheres, or coronas, with temperatures of about 555,000 degrees C (one million degrees F). Ground observatories cannot study these coronas effectively, but IUE instrumentation will be able to examine them to determine their temperatures, density and chemical composition. The functions of our own Sun are expected to be better understood as a result of these investigations.

The interstellar medium of our galaxy and even the planets of our own solar system will also come in for intensive study. The gas and dust of the interstellar medium are believed to be the product of exploding stars and the material out of which new stars are born. Scientists are interested in the composition of the "grains" floating in the space between the stars and wish to learn more about them and how our own star was born.

Another target of IUE will be Jupiter and other planets in the solar system. Even though we have taken closeup pictures of the planets and of some of their moons, scant information is available concerning their emissions in the ultraviolet. Jupiter's giant red spot is of special interest, along with the four larger Jovian moons, IO, Europa, Ganymede and Callisto, and their atmospheres.

IUE will complement and extend observations made by the two NASA Orbiting Astronomical Observatories, OAO-2 and Copernicus, and ESA's TD-1 satellite. IUE will be followed by the 10-ton space telescope which will be launched by the Space Shuttle in 1983. IUE will provide a rehearsal for one of the most important objectives of the space telescope—a system for observing by astronomers of all nations.



IUE at Launch—Delta 138 launched the International Ultraviolet Explorer satellite Jan. 26 from complex 17 at Cape Canaveral.

The first facilities for such observations have been established for IUE by NASA at the Goddard Space Flight Center, and by ESA near Madrid, Spain.

Even though their spacecraft operations background may be limited, astronomers from different countries will be able to use the IUE observatories without undergoing tedious training courses in specialized techniques. They can go into the IUE scientific control center at Goddard, for example, identify their targets, and begin collecting data much as they would in a ground-based observatory.

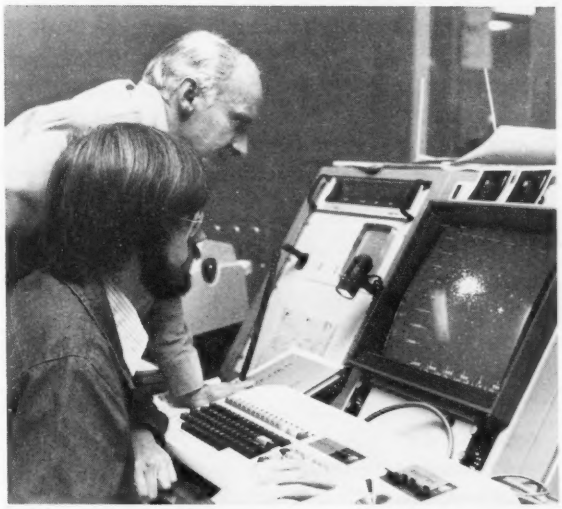
Because of IUE's geosynchronous orbit, the astronomers will be able to observe a wide variety of objects repeatedly over long periods. Repetition of observations through use of ground-based equipment has demonstrated that the spectra of many stars vary with time.

The spacecraft itself is an octagonal structure with the telescope protruding from the top and a fixed solar array on two opposite sides (see illustration). When stabilized, it is designed to always maintain one side of the two arrays toward the Sun.

Spacecraft structure is of a modular design, allowing easy installation or removal of its various assemblies and components. Total weight is 671 kilograms including the apogee boost motor. It stands 4.3 meters tall and is 1.3 m in diameter at launch. When the solar arrays are unfolded in space, the structure is 4.3 m wide. An apogee boost motor propellant places the spacecraft in its eccentric synchronous Earth orbit, 46,000 km by 25,000 km.

At that altitude, the spacecraft will appear to drift back and forth over the equator during its expected three-year lifetime, ranging to about 29 degrees North and South latitudes. It will be in constant view from the Goddard station and in view at least 10 hours a day from the Madrid station. Onboard, hydrazine gasjets will keep the spacecraft on station with a mean longitude of 71 degrees West.

The Goddard center is responsible for the design, integration and testing of IUE, and provides the U.S. ground support facilities. ESA built the solar array and the Madrid ground facilities. Britain's SRC, in



Fast-working Satellite—Only 12 days after launch, the IUE returned pictures of the first star observed. Watching the image on a viewing screen at the Goddard center are Jerry Longanecker, project management (standing) and Fred Espaneak, telescope operator. The picture is taken from a screen that displays the star field mapped by IUE's fine error sensor; the selected target is then observed by a vidicon camera to obtain the ultraviolet spectra.

collaboration with University College, London, provided the four television camera detectors for transforming the spectral displays into video signals for transmission to the ground.

In accordance with agreements reached by the three participating agencies, viewing time will be allocated on a one-third, two-thirds basis. NASA will have 16 hours of viewing time and then will turn over the spacecraft to ESA for an eight-hour viewing block to be shared equally by ESA and the United Kingdom.

Goddard manages the Delta rocket program for NASA. McDonnell Douglas Astronautics Co., Huntington Beach, Calif., is the prime contractor.

GLOSSARY OF IUE TERMINOLOGY

Binary Star—A pair of stars orbiting about each other under mutual gravitational attraction.

Black Holes—Objects resulting from complete gravitational collapse beyond that of a neutron star. The accompanying gravitational field is so intense that no radiation can escape.

Electromagnetic spectrum—The ordered array of known electromagnetic radiations, extending from those with the shortest wavelengths, cosmic rays, through gamma rays, X-rays, ultraviolet radiation, visible radiation and including microwave and all other wavelengths of radio energy.

Exploding Galaxies—Violent, energetic explosions centered in certain galactic nuclei where the total mass of ejected material is comparable to 5 million average stars. Jets of gas 1,000 light years long are typical.

Galaxy—A large system of stars held together by mutual gravitational attraction.

Neutron Stars—Remnants of supernovae explosions. They consist of ultra-dense matter composed almost entirely of neutrons which have been squeezed together by the force of gravity exerted by the collapsing matter.
force of gravity exerted by the collapsing matter.

Pulsars—Believed to be rotating neutron stars. The intensity of their radiation in the electromagnetic spectrum is modulated by the period of rotation. Additional periodicities have also been observed.

Quasars—Quasi-stellar objects. Very controversial. Quasars seem to be the size of large stars, yet they emit energy at all wavelengths comparable to that of a thousand galaxies. Characterized by very large redshifts.

Seyfert Galaxies—Unusual spiral galaxies characterized by small, extremely bright nuclei containing one to 10 billion stars. They are orders of magnitude brighter in the X-ray than in the visible part of the spectrum.

Supernova—A catastrophic stellar explosion occurring near the end of a star's life in which the star collapses and explodes, manufacturing the heavy elements which it spews out into space. Visible luminosity may reach 100 million times that of the Sun.

Ultraviolet Radiation—Electromagnetic radiation of shorter wavelength than visible radiation; roughly, radiation in the wavelength interval from 100 to 400 Angstroms.

New NASA Director

Frank E. Penaranda was appointed Director of the institutional operations division, Office of Management Operations in January. Penaranda is responsible for managing NASA's R&PM budget and institutional management system, including the program support negotiations between the centers and program offices; coordinating agency-wide civil service and support contractor manpower planning, evaluation, and control; and overseeing the aircraft operations function at the centers.

For the past four years Penaranda has served as director of the resources and management systems division, OAST. Previously, he had served in various other positions in that division since he joined NASA in 1969. Penaranda has been responsible for managing the R&PM and R&D budgets for OAST, as well as for program support activities.

Penaranda came to NASA in April 1969 from the Armed Forces Radiobiology Research Institute where, as a nuclear research physicist, he conducted theoretical analyses and research on nuclear particle transport and shielding phenomena. He also directed the institute's ADP and data acquisition systems.

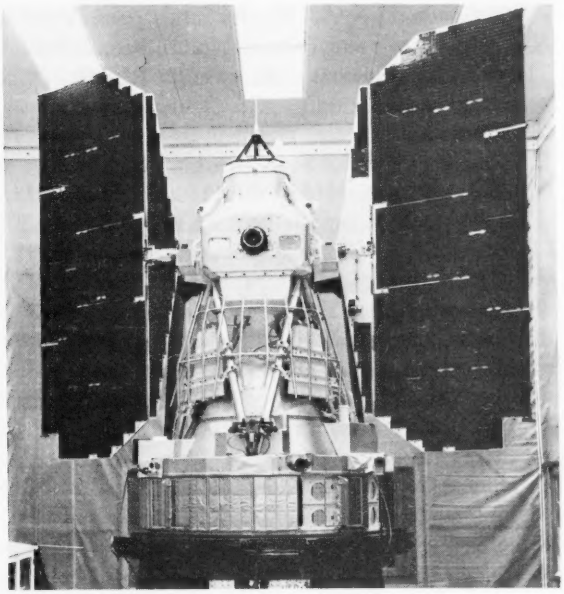
He holds Bachelor's and Master's degrees from Manhattan College and Marquette University, respectively. He also is a graduate of the Federal Executive Institute and Harvard's Advanced Management Program.

Landsat Ground Receiving Station to Be Built

India plans to build a Landsat ground station designed to receive data directly from NASA's Earth resources satellites under a recently concluded agreement between the United States and India.

The new ground station, to be built and operated by the India National Remote Sensing Agency (NRSA) at Hyderabad in the south central Indian state of Andhra Pradesh, will be capable of receiving, processing and disseminating data covering all India and much of the surrounding region.

The agreement was signed by U.S. Secretary of State Cyrus R. Vance, and India's Minister of External Affairs, Atal Bihari Vajpayee. Establishment of the Hyderabad station will facilitate sharing by Indian and neighboring countries of the practical benefits of satellite remote sensing technology. These benefits include the capability to regularly monitor land cover and geological features as well as observe constantly changing conditions of agriculture, water and natural resources.



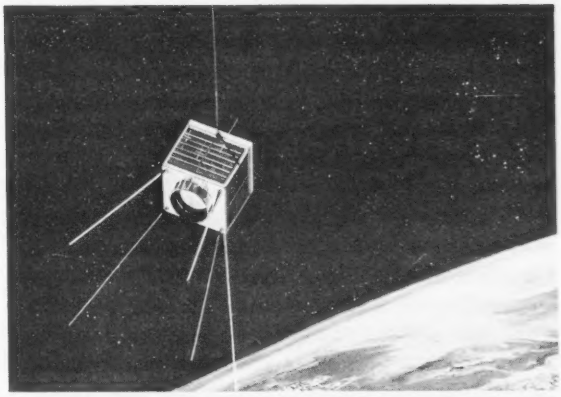
New Earth Resources Technology Satellite—Landsat-3 at the Goddard Space Flight Center as it was being made ready for launch in early March from the Western Test Range (Lompoc, Calif.) aboard a two-stage Delta launch vehicle. Riding piggyback aboard the rocket will be an amateur radio communication satellite, the Oscar-D. That satellite will be used by amateur radio buffs around the world for many purposes. Its primary function will involve its application as a teaching aid in secondary schools.

The agreement requires that NRSA make copies of Landsat data available to anyone of the region requesting such data. NRSA also has agreed to share the cost of operating the Landsat satellites by paying NASA the annual access fee beginning six months after the Hyderabad station begins receiving data.

The Hyderabad station will be capable of receiving data from the currently operating Landsat-2 as well as Landsat-C, scheduled for launch in March, and Landsat-D, to be launched in 1981. Four Landsat ground stations are already in operation outside the U.S.: at Prince Albert, Saskatchewan and Shoe Cove, Newfoundland, Canada; Cuiaba, Brazil; and Fucino, Italy. Iran will begin receiving Landsat data from facilities near Tehran later this year. Chile, Zaire and Argentina have signed agreements to build their own Landsat stations. U.S. ground stations for Landsat are located at Fairbanks, Alaska; Goldstone, Calif.; and at NASA's Goddard Space Flight Center.

Landsat data have been used by hundreds of scientists and local officials in the U.S. and more than 100 foreign countries use wide-ranging programs to develop and encourage further applications of remote sensing techniques from satellites.

Data have been purchased by scientists in more than 100 countries from the U.S. Department of Interior's Earth Resources Observations Systems Data Center in Sioux Falls, S.D. More than 120,000 separate views of the Earth from NASA's Landsats have been provided to EROS, where independent scientists and the general public may obtain material for a nominal fee.



Piggyback Rider—An artist's concept of the AMSAT-OSCAR-D, the eighth in a series of satellites built by radio amateurs in a program that began with the launch of OSCAR-1 in 1961. The latest Oscar was launched as a piggyback payload by NASA aboard a Delta launch vehicle in March. The prime payload for the Delta is Landsat-C.

Medical Programs Broadcast Live via Lewis-Managed Satellite

An extensive series of medical seminars were broadcast live to 30 hospitals of the greater Cleveland Hospital Association during January via the high-powered communications satellite managed by the NASA's Lewis Research Center.

The continuing education programs, sponsored by the Medical University of South Carolina, also are being broadcast at the same time to hospitals in South Carolina and numerous other sites within the 16-state Southern Educational Communications Association.

Originating from South Carolina, the broadcasts are being picked up by Lewis' Portable Earth Terminal (PET). PET is a special van-like vehicle equipped with a television studio, antenna, color television cameras and other equipment that can broadcast and receive television and voice via the communications technology satellite (CTS) to and from locations all around the country.

PET relays the South Carolina broadcasts to the CTS satellite which, in turn, directs them to Cleveland's educational television station, WVIZ. WVIZ, with a special megahertz system which reaches many hospitals and eight long-term care facilities here, re-transmits the signals to the local hospitals.

Twenty-one hours of programming were scheduled on alternate days, covering subjects such as: recognizing the depressed patient; intraocular lens implantation; nuclear medicine; cardiovascular research; and a drug interaction series.

This programming is part of a continuing series of experiments being managed by the Lewis center to demonstrate the feasibility of using high-power satellite communication to bring educational, medical, business and similar conferences to areas ordinarily remote from commercial television broadcasting systems.

CTS, the world's most powerful communications satellite, is managed by the United States and Canada. Launched in 1976, the spacecraft operates in a new frequency band at power levels 10 to 20 times higher than other such satellites. This higher broadcast power makes it possible to use much smaller and relatively inexpensive ground receiving equipment.

The Lewis center provides management for all of the U.S. experiments conducted via CTS, and developed the high-powered transmitting tube that gives the satellite its high broadcast capability.

New NASA Publications

Apollo-Soyuz Pamphlets 1 through 9—A series of educational publications (EP-133 through EP-141) based on the science and technological experiments conducted during the Apollo Soyuz Test Project. Subtitles of the pamphlets, produced by NASA's office of public affairs, are: The Flight; X-Rays, Gamma Rays; Sun, Stars and in Between; Gravitational Field; the Earth from Orbit; Cosmic Ray Dosage; Biology in Zero-G; Zero-G Technology; and General Science. The U.S. Government Printing Office, Washington, D.C. 20402, sells the books in complete sets of nine only. Price is $10.00.

Viking Pictures of Mars: Set #1. This package, produced by NASA's office of public affairs, contains nine 12 x 25 inch lithographs (color and black-and-white) and a keyed sheet explaining each picture. These historic and graphic pictures of Mars include a striking computer-enhanced Martian sunset. The U.S. Government Printing Office sells the set of pictures for $3.50.

Lunar Impact—A History of Project Ranger (NASA SP-4210), by R. Cargill Hall, is a new publication in the NASA History Series, issued by NASA's Scientific and Technical Information Office. The 472-page volume is a history of the Ranger project, from 1960 through 1965, and its impact on the exploration of space. The book is for sale by the U.S. Printing Office for $6.25, stock no. 033-000-00699-3, catalog No. NAS 1.21:4210, priced at $6.25.

Liquid Rocket Lines, Bellows, Flexible Hoses, and Filters (NASA SP-8123) is a new NASA space vehicle design criteria monograph in the series on chemical propulsion. The document was prepared at the Lewis center as part of NASA's program to establish uniform criteria for the design of space vehicles. The 192-page volume is for sale by the National Technical Information Service, Springfield, Va. 22161 for $6.75.

National Geodetic Satellite Program (NASA SP-365) is a report of the major objectives and results of the satellite geodesy program. Supporting data are presented where appropriate. The 1,045-page book is for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for $12.25.

Experiments Selected for Shuttle Flight

Sixteen new experiments in space technology have been selected for NASA's Long Duration Exposure Facility (LDEF) mission, currently scheduled as the payload for the first operational flight of the Space Shuttle in 1980. The experiments join seven other technology experiments selected earlier this year.

LDEF, managed by NASA's Langley Research Center, is a reusable, unmanned, free-flying structure on which many different technical and scientific experiments can be mounted in special trays. The facility provides an easy and economical way to conduct primarily passive experiments in Earth orbit.

After launch inside the Shuttle Orbiter's cargo bay from NASA's Kennedy Space Center, LDEF will be placed in a circular Earth orbit of at least 330 kilometers with an inclination to the equator of 28.5 degrees. The facility will remain in orbit from 6 to 12 months while its experiments are exposed to the environment of space. At mission's end, it will be retrieved by the orbiter and returned to Earth. Experiments will be returned to their investigators for analysis of data collected.

The Shuttle is scheduled to begin a series of six operational test flights in 1979. Once completed, the operational flights will begin. LDEF is currently planned as the payload for the first operational flight in 1980.

The 16 new experiments were chosen from among 190 submitted to NASA in response to an announcement of opportunity distributed in June 1976. Candidates came from industry, government institutions, universities, and eight foreign countries or were simply interested individuals. Investigators for the experiments selected to date represent six universities, six private companies or research institutes and five NASA research centers. Seven of the experiments are from France, two from England and one from Canada.

With selection of the new experiments, 80 percent of LDEF's experiment trays are now filled with research projects. The remaining 20 percent of experiment space will contain micrometeoroid detection panels, designed to measure the number and variety of tiny meteoroid particles in Earth orbit.

Experiments were selected for their research and development value, their compatibility with LDEF and other experiments and the cost of the effort. Some experiments were too costly for NASA. Rejected experimenters, however, were offered the opportunity to have their experiments flown aboard LDEF if there was no charge to NASA.

Technical areas represented by the experiments include materials, thermal control coatings, detectors, power, micrometeoroids, electronics, lubrication, optics and space debris detection.

Newly selected experiments and their principal investigators are:

- **Influence of Extended Exposure in Space on Mechanical Properties of High-Toughness Graphite-Epoxy Composite Material.** Investigator: Dr. David K. Felbeck, University of Michigan, Ann Arbor.
- **Atomic Oxygen Stimulated Outgassing.** Investigators: Dr. Robert L. Scott, Jr., Southern University, Baton Rouge, La., and Roger C. Linton, NASA Marshall Space Flight Center.
- **Space Testing of Holographic Data Storage Crystals.** Investigators: Drs. Thomas K. Gaylord and W. Russell Callan, Georgia Institute of Technology, Atlanta.
- **Space Plasma-High Voltage Drainage.** Investigator: Dr. J. M. Sellen, Jr., TRW Defense and Space Systems Group, Redondo Beach, Calif.
- **Passive Exposure of Earth Radiation Budget Experiment Components.** Investigators: John H. Hickey and Francis J. Griffin, Eppley Laboratory, Inc., Newport, R.I.
- **Advanced Solar Array Technology.** Investigators: Edward M. Gaddy and James A. Bass, NASA Goddard Space Flight Center.
- **Space Evaluation of Advanced Solar Array.** Investigators: Ann Whitaker, Charles F. Smith and Leighton E. Young of the Marshall Space Flight Center.
- **Solar Array Materials and Assembly Techniques Evaluation.** Investigator: Ernest N. Costogue, NASA Jet Propulsion Laboratory.
- **Evaluation of Long-Duration Exposure to Natural Space Environment on Graphite-Polyimide Mechanical Properties.** Investigator: J. H. Powell, Rockwell International, Tulsa, Okla.
- **Evaluation of Long-Duration Exposure to Natural Space Environment on Space Shuttle Payload Bay Door Graphite-Epoxy Mechanical Properties.** Investigator: D. W. Welch, Rockwell International, Tulsa, Okla.
- **Study of Factors Determining Radiation Sensitivity of Quartz Crystal Oscillators.** Investigator: Dr. John D. Venables, Martin Marietta Corp., Baltimore, Md.

• **Multiple Foil Microabrasion Package.** Investigators: Dr. J. A. M. McDonnell, Dr. D. G. Ashworth, W. C. Carey, Dr. R. P. Flavill and R. C. Jennison, University of Kent, Canterbury, United Kingdom.

• **Exposure to Space Radiation of High-Performance Infrared Multilayer Filters.** Investigators: Dr. J. S. Seeley and R. Hunneman, University of Reading, United Kingdom.

• **French Cooperative Passive Payload.** Investigators: J. F. Crifo and J. M. Berset, Centre National de la Recherche, Scientifique, Laboratoire de Physique Stellaire et Planetaire, Verriers-le-Buisson, France; J. Bourrieau, Dr. J. C. Mandeville and A. Paillous, ONERA/DERTS, Toulouse, Cedex, France; J. Flamand, ISA Longjumeau, France; and A. Malherbe, MATRA, Rueil Cedex, France.

• **The Effect of Space Environment Exposure on the Properties of Polymer Matrix Composite Materials.** Investigators: Drs. R. C. Tennyson and J. S. Hansen, University of Toronto, Ontario, Canada.

• **Synergistic Effects of Space Environment on the Properties of Metallized Dielectrics.** Investigators: Drs. R. J. DeIasi and T. Hilgeman and Mr. M. L. Rossi, Grumman Aerospace Corp., Bethpage, N.Y.

Previously selected experiments are:

• **Orbital Lubrication Experiment.** Investigator: B. J. Perrin, Ball Brothers Research Corp., Boulder, Colo.

• **Effects of Long-Duration Exposure on Active Optical Systems Components.** Investigators: D. M. Blue and J. J. Gallagher, Georgia Institute of Technology, Atlanta.

• **Space Debris Experiment.** Investigator: Donald H. Humes, NASA Langley Research Center.

• **Fiber Optic Experiment.** Investigator: Dr. Alan R. Johnston, NASA Jet Propulsion Laboratory.

• **Advanced Photovoltaics.** Investigators: Henry W. Brandhorst, Jr., A. F. Forestieri and D. T. Bernatowicz, NASA Lewis Research Center, Ceveland, Ohio.

• **Thermal Control Surfaces** (both Active and Passive.) Investigators (Active): Donald R. Wilkes and H. M. King, NASA Marshall Space Flight Center, Huntsville, Ala. Investigator (Passive): Wayne Slemp, NASA Langley Research Center, Hampton, Va.

Pulitzer Prize-winning Author—James A. Michener, the author of numerous literary works, was guest speaker recently at the Langley center activities center and the Hampton (Va.) Coliseum. His subject was "The Future of the American Family," in the NASA-College of William and Mary sponsored public lecture series "Our Future in the Cosmos."

NASA Award Aimed at Minority Children

NASA has awarded a $45,000 contract to the Cleveland chapter of the National Technical Association to establish a career awareness program at two East Cleveland public schools. The program, already underway, is being conducted at Kirk Middle School and Shaw High School. Its purpose is to involve more minority children in science and engineering careers.

About 60 students from each school are participating in the program. They were nominated and selected by their teachers on the basis of grades and interest levels of the students.

Each student devotes four hours a week to CAP, learning basic engineering principles and then applying them to assigned science construction projects. This early in the program, the group at Kirk Middle School has assembled a crystal radio and the students at Shaw have built an AM radio transmitter kit.

Black professionals from all areas of the engineering field visit the students to lecture and demonstrate their work. Field trips to organizations specializing in science and engineering as well as a special motivational series on organization, leadership, report writing, analyses and development of large-scale science projects are planned. A three- to six-week concentrated summer program, including science project construction and local field trips, may be added.

Julian Earls and Harold Ferguson, both NASA Lewis Research Center engineers and National Technical Association members, originated the program for Cleveland.

NASA will fund CAP for one year. At the conclusion of the initial program, a study will be made to check for improvement in the grades of the students and the number of middle- and high-school students taking additional science studies compared to the historical percentage.

If CAP proves a success, as expected, the National Technical Association will turn the program over to the school system. The association is an organization dedicated to disseminating information concerning opportunities available in the scientific fields and to providing guidance counseling to minority youths.

The Cleveland Chapter, of which 11 Lewis center engineers are members, was chartered in 1974 and has been active throughout the state of Ohio in assisting high school counselors to provide students with technical career information, sponsoring special programs for young people, and providing an opportunity for personal contact by young blacks with practicing black technicians.

New Appointment in Applications Office

Dr. S. Ichtiaque Rasool was appointed to serve as the chief scientist for the Office of Space and Terrestrial Applications on Jan. 1.

In his new position, Rasool will maintain an active relationship with the scientific community at large, specifically academic, industrial, and government organizations involved with the development and use of scientific and technological instrumentation, theory, and techniques for the study of Earth and near-Earth space environment for the direct benefit of human life.

He also will serve as the chairman of the Space and Terrestrial Applications steering committee and will represent the Office of Space and Terrestrial Applications to the National Research Council, Space Science, Space Applications, and Climate Research Boards.

Rasool came to NASA from the National Academy of Sciences in January 1965. He served as senior research scientist at the Goddard Institute for Space Studies until November 1971. He then became deputy director for planetary programs in the Office of Space Science. In October 1974, he became special assistant to the Deputy Associate Administrator. He served in that position until August 1975, when he was named Deputy Associate Administrator for Space Science (Science,.

Rasool was born in Lucknow, India. He received his B.S. degree from the University of Lucknow in 1950 and in 1956 his Ph.D. in Physics from the University of Paris, France.

Russian VIPs Visit U.S. Space Center—Ten delegates from the Supreme Soviet (the top parliamentary body of the USSR), headed by Boris N. Ponomareve of the Politburo of the Central Committee of the Communist Party of the Soviet Union and of the Council of Nationalities, recently toured the Johnson center. They were accompanied by 17 of their countrymen and by representatives of the U.S. State Department, the U.S. Senate and House of Representatives, and the U.S. Army. In this photo, the party is being shown medical kits used on Skylab.

Did You Know?

More than $4 million has been pumped into the Huntsville-Madison County economy by visitors to the Alabama Space and Rocket Center, according to an estimate by the museum's director. Attendance was up 15 percent during 1977, setting a record number of visitors to the museum for two years in a row. About 1.7 million people have visited the center since it opened in 1970, many of whom also toured the Marshall center.

At the Kennedy center, 1,117,603 persons toured the space exhibition area in 1977, bringing the all-time total (since 1966) to 11,490,332.

NASA's public archives of data collected by satellites and aircraft are growing at the rate of 100 billion bits (eight "bits" are equal to one character or number) per day. Acquisition and storage of this continuous stream of data, and the job of making it readily available to users is rapidly becoming a major and costly problem. The magnetic tape and microfilm on which the data are stored requires acres of space in buildings with carefully regulated humidity and air conditioning. Present storage and maintenance costs are estimated at $300 million per year, and requirements are constantly increasing. Five NASA field centers are participating in a program to ease the burden—Marshall, Goddard, Langley, JPL and JSC.

The second Space Shuttle solid rocket development motor was successfully static fired Jan. 18 at the Thiokol Chemical Corp.'s Wasatch Division in Utah. Preliminary inspection of the outside of the motor case and the nozzle revealed no unexpected effects. Qualitative looks at preliminary data have shown no significant anomalies. The motor weighs 568,097 kilograms (1,252,419 pounds) fueled and produces 12,232,550 newtons (2.75 million lbs.) of thrust. The Marshall center is managing testing of the motor by Thiokol.

Sunday drive-through tours of the Kennedy center and adjacent Cape Canaveral Air Force Station were resumed Jan. 29. Visitors may gain access to the NASA reservation via the NASA causeway off U.S. Route 1 two miles south of Titusville or Florida Route 3 on Merritt Island.

Contractor News

Honeywell Information Systems, Federal Systems Division of McLean, Va., has been awarded a contract by NASA's Kennedy center for delivery of a central data subsystem for Space Shuttle launch processing. The basic contract is for $3,544,832. With the exercise of various options in the amount of $11,160,595, total contract value can reach $14,705,427. The central data subsystem is one of two major elements of the Space Shuttle launch processing system developed by KSC for automated checkout of main Shuttle components from their arrival at the center until launch and then from orbiter landing to subsequent Shuttle launch.

Rockwell International Space Division has signed two amendments to the Space Shuttle orbiter contract with the Johnson center covering spare parts and test articles with a combined value of $12,825,947.

The Singer Co., Link Division, has won a supplemental agreement to its contract with the Johnson center to cover design, manufacture, installation and testing of a Spacelab simulator. The supplement to the cost-plus-award-fee contract is valued at $5 million. The new simulator will be tied into the Space Shuttle mission simulator at the Johnson center for training of flight crews and flight controllers in Shuttle spacecraft and Spacelab systems operations.

The Hughes Aircraft Co., Space and Communications Group of El Segundo, Calif., has won a $4.3 million contract with NASA's Lewis center to provide an auxiliary electric propulsion flight system and associated hardware. The cost-plus-fixed-fee contract will run for about three years from beginning date of Jan. 16, 1978.

The Ford Motor Co., of Dearborn, Mich. will evaluate the use of current high-temperature ceramics for stators in automotive gas-turbine engines for the Lewis center under a $1,311,735 contract. The 18-month contract, part of a program NASA manages for the Department of Energy, began Jan. 23, 1978. The company will develop a system for reliably predicting the life of ceramic stators, and will fabricate and test the devices under simulated engine conditions.

The Holloway Corp. of Titusville, Fla., has been awarded a contract for $3,227,300 by the Kennedy center. The fixed price contract is for the construction of a solid rocket booster recovery and disassembly facility at hangar AF, Cape Canaveral Air Force Station in connection with the Space Shuttle program.

Detente Reached on Polar Bear's Trek

United Press International recently published the following news item concerning the tracking of a pregnant polar bear in the frozen reaches of Alaska.

"Soviet authorities promised yesterday to come to the aid of a pregnant and possibly homesick polar bear that roamed from Alaska into Soviet territory.

" 'We shall certainly help our American colleagues in searching for that courageous traveler,' Soviet official Savva Uspensky told the newspaper *Sotsialisticheskaya Industria.*

"The bear was one of two caught by officers of the U.S. Fish and Game Department in Alaska last June and collared with a radio transmitting device. Scientists used a satellite [Nimbus-6, since last June] to pick up the signals and follow the bears through the Arctic.

"The male managed to get rid of his collar but signals from the female indicated she is now about 150 miles from Wrangel Island, which is 450 miles northeast of the Bering Strait. U.S. scientists asked the Soviets to try to trace and help her if necessary.

"Uspensky, director of the Central Laboratory for the Protection of Nature of the Soviet Ministry of Agriculture, said Soviet officials would give 'a warm reception to this transgressor of state borders.'

" 'When we meet her, we'll examine her, replace the dying batteries in the radio transmitter and give the result of our observations to American scientists,' he said.

"Uspensky said that, expecting to give birth, the bear may have entered a den on an ice floe.

" 'Polar bears are pregnant for 230 to 250 days and to cover such a distance of 1,240 miles in such a state is a very difficult thing even for such a strong animal,' he said. 'Maybe she was born in our territory and crossed the borders of two countries and continents to give life to her children in the place of her own birth.' "

The most up-to-date information available suggests to NASA bear watchers that the animal may have entered a den to await the birth of her young. (Unlike most other bears, polar bears do not hibernate—only the pregnant females remain in dens.) Nimbus tracking is the basis for the current belief that the bear may be on a large ice floe which is moving only slightly—some movement is evident, but the rate is very much slower than the bear's earlier rate of travel.

Knocked Out Bear—The female polar bear at the time she was inoculated with a harmless drug to permit fitting her with a collar containing a radio transmitter. After the bear regained consciousness, she wandered over more than 1,000 miles of Alaskan territory while pregnant, tracked by a NASA satellite.

Launches for 1978—Completed and Projected

Name	Launch Date	Vehicle	Range	Mission Remarks
Intelsat IVA-(F3)	Jan. 6	Atlas-Centaur	ETR	Improved communications satellite for Comsat. Reimbursable.
IUE-A	Jan. 26	Delta	ETR	International Ultraviolet Explorer—cooperative with ESA. Designed to obtain high resolution data on stars and planets in the ultraviolet region of the spectrum.
FLTSATCOM-A	Feb. 9	Atlas-Centaur	ETR	Navy fleet satellite communications. Reimbursable.
Landsat-C	March 5	Delta	WTR	Third Earth resources technology satellite.
Japan/BSE-A	March 23	Delta	ETR	Broadcasting satellite experimental. Japanese communications satellite for conducting TV broadcast experiments. Reimbursable.
Intelsat IVA-F6	March 30	Atlas-Centaur	ETR	Improved communications satellite for Comsat. Reimbursablie.
AEM-1 (HCMM)	April 27	Scout	WTR	Heat capacity mapping mission to produce thermal maps for thermal inertial measurements, investigate feasibility of geothermal source location by remote sensing, and provide coverage of snow field for water runoff prediction.
OTS-B	April 30	Delta	ETR	ESA orbital Test Satellite.
NOAA/ GOES-C	May	Delta	ETR	Part of global network of geostationary environmental satellites to provide Earth imaging, monitor the space environment, and relay meterological data to users. Reimbursable.
Pioneer Venus-A	May 20	Atlas-Centaur	ETR	Planetary mission to Venus. Orbiter will measure upper atmosphere and ionosphere, study interaction between solar wind and ionosphere and magnetic field, study atmospheric and surface characteristics, determine gravitational field harmonics.
Seasat-A	May	Atlas-F	WTR	Sea satellite for global monitoring of ocean geoid, wave topography, surface wind speed and direction, ocean surface temperature, and ice field extent and dynamics.
Comstar-C	June	Atlas-Centaur	ETR	Third in a series of domestic communications satellites for Comsat. Reimbursable.
ESA/GEOS-B	June	Delta	ETR	ESA spacecraft to conduct scientific investigation of waves and particles in magnetosphere. Reimbursable.
Japan Backup	June	Delta	ETR	Backup spacecraft for Japan. Reimbursable.
TIROS-N	July	Atlas-F	WTR	Polar orbiting operational spacecraft to provide improve meteorological data for NOMSS and provide support to GARP.
UK-6	July	Scout	WI	United Kingdom spacecraft to measure ultra-heavy cosmic ray particles and study low-energy cosmic X-rays and the fast secular behavior of X-ray sources. Reimbursable.

ISEE-C	July	Delta	ETR	International Sun Earth Explorer. An extension of interplanetary studies with the spacecraft toward the Sun sufficiently outside the Earth's influence for comparison with results of ISEE-A and B missions and of probes to outer planets.
Nimbus-G	Aug.	Delta	WTR	Develop and flight test advanced sensors and technology basic to conducting experiments in the pollution monitoring, oceanographic, and meteorological disciplines.
Pioneer Venus-B	Aug.	Atlas-Centaur	ETR	Multiprobe—will determine nature and composition of clouds, composition structure and general circulation pattern of the atmosphere of Venus from the surface to high altitudes, study interaction between planetary environment and interplanetary medium.
Navy-20	Sept.	Scout	WTR	Navy navigation satellite. Reimbursable. (Call-up.)
NATO III-C	Sept.	Delta	ETR	Communications satellite, second in series.
NOAA-A	Sept.	Atlas-F	WTR	Advanced operational prototype spacecraft and sensors for a third generation series of operational meteorological satellites. Reimbursable.
HEAO-B	Oct.	Atlas-Centaur	ETR	Second high energy astronomical observatory to study highly energetic radiation from space.
Telesat-D	Nov.	Delta	ETR	Canadian domestic communications satellite. Reimbursable.
FLTSATCOM-B	Nov.	Atlas-Centaur	ETR	Navy fleet satellite communications. Reimbursable.

X-ray Device Works on Structures—The Lixiscope (Low Intensity X-ray Imaging Scope)—described in detail in the January issue of NASA *Activities*—can inspect not only internal human features but structural fixtures as well. In this photo, Dr. Lo I Yin of the Goddard center views a nail embedded in the wall of a 130-year-old house in Virginia. Looking on is Eldon Wood of a Virginia architectural firm. The Lixiscope, still in prototype form, is seen as a means of studying the structural integrity of old buildings.

Sign Language Explains NASA Program—At the Dryden center, teacher Margaret Azevedo of the Kern County (Calif.) Regional Center for the Deaf and Hard of Hearing, translates tour guide Dick Klein's narrative into sign language for center students on tour. The group got a close look at NASA's Space Shuttle *Enterprise*, which was undergoing modifications before being flown to the Marshall center for vibration tests.

Another Dividend from Air and Space

Research and development in aeronautics and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

A New Concept for Fighting Fires at Sea

In a joint undertaking, NASA and the U.S. Coast Guard have developed and built a prototype lightweight, portable fire-fighting module for use in combating shipboard and dock fires. The module was demonstrated at the Monroe dry dock in Boston Harbor, Mass., in early February and put on public display on Feb. 20.

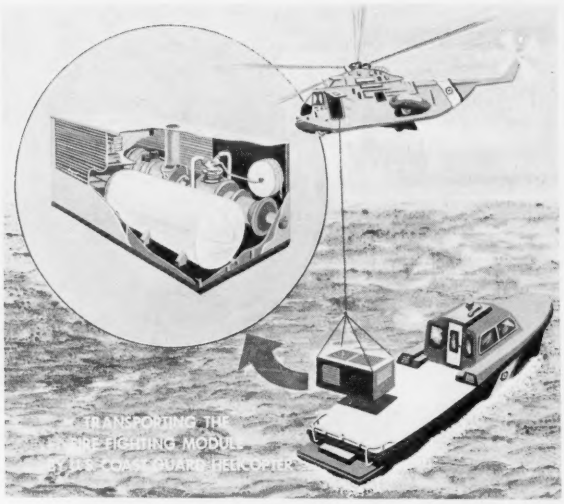
The device is a completely self-contained pumping system, capable of being lifted by helicopter or dock crane onto the deck of almost any kind of boat. It carries its own pumps, hose, fire-fighting suits and other necessary equipment; and it is capable of pumping water from the sea at a rate of up to 7,570 liters per minute for periods of up to three hours.

The module was designed at the Marshall Space Flight Center. The prototype was constructed at the Northern Research Engineering Co., Cambridge, Mass. It is expected that the unit eventually will be available commercially to fire departments throughout the country.

The Coast Guard requested NASA's participation in the project because of the agency's long experience in space with high-capacity, lightweight fuel pumps developed for rocket engines.

The work was directed by the Marshall center's Technology Utilization Office as an engineering applications program of the NASA Technology Utilization Office.

The control panel and the Diesel-powered exhaust pipes of the NASA-developed fire-fighting module are shown in this photo of a prototype put on public display recently at Boston Harbor.



NASA
National Aeronautics and Space Administration